Peer Review Workgroup Comments on *Exposure Analysis for Dioxins, Dibenzofurans, and CoPlanar Polychlorinated Biphenyls in Sewage Sludge – Technical Background Document; Risk Characterization;* and *Estimate of Population Exposed to Dioxins from the Land Application of Sewage Sludge and Corresponding Number of Annual Cancer Cases from this Exposure*

by Robert J. Fares

General Comments:

Overall, the Technical Background Document was a pleasure to read. Obviously, a lot of thought went into the production of this document. The document generally follows the same format as *Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions* (U.S. EPA, 1998) and has even retained many of the model component names and symbols introduced in that document. The rationale for model development and descriptions of the model components are clear and explicit, and the discussions regarding the development of probability distribution functions (PDF) and exposure point concentration (EPC) estimation was thorough. However, the Technical Background Document had some shortcomings. Specifically, Tables in the document that are supposed to present percentile concentrations estimated using the single sample of dioxins, furans, and PCBs as the fixed congener concentrations in the model were blank. Additionally, the equations in Appendix H are missing their operands. All of the operands in the equations are replaced by vertical rectangles, probably the result of the use of incompatible fonts used in the author's equation editor. Consequently, that limited the evaluation of the equations. Several specific comments follow that point to missing information and minor discrepancies identified throughout the document

Document No. 1 (The Technical Support Document)

Robert Fares

Response to Charge no. 1 - ***Is the selection of exposure pathways scientifically reasonable for appropriate characterization of the exposure evaluation as "high end" within the meaning of EPA's Guidelines for Exposure Assessment?***

The exposure pathways presented in the Technical Support Document incorporate data to account for conditions at geographic locations throughout the United States that result in higher concentrations of dioxins, furans, and PCBs in air, soil, and sediment, and increased transfer to vegetation, farm animals, and fish. Inclusion of these data in the assessment ensured that high end exposure could be characterized in addition to central tendency estimates for farm families and recreational fishers.

Robert Fares

Response to Charge no. 2 - ***Is the modeling of the accumulation of dioxins in the soils from the land application of biosolids at several land application scenario sites and the accumulation of dioxins in the subsurface environment from the surface disposal of biosolids, including the half***

life assumptions of applied dioxins as a function of incorporation/burial/stacking depth and application method technically adequate?

The half-life assumptions and modeling approach to depict accumulation of dioxins in soils resulting from land application of biosolids appears to be adequate.

Robert Fares

Response to Charge no. 3 - ***Are the exposure pathway algorithms used to estimate dioxins exposure to the population modeled for each of the identified exposure pathways correct and transparent?***

The exposure pathway algorithms described in the body of the Technical Support Document appear to be correct, and the discussions regarding the equations (including justification for specific assumptions) make them quite transparent. However, the equations in Appendix H are missing their operands. All of the operands in the equations are replaced by vertical rectangles, probably the result of the use of incompatible fonts used in the author's equation editor. Consequently, that limited the transparency of the equations and made it difficult to evaluate the correctness of certain equations.

Robert Fares

Response to Charge no. 4 - ***Are the algorithms used to model the fate of dioxins in biosolids applied to the land and the fate of dioxins in biosolids surface disposed with particular emphasis on bioaccumulation and transport to groundwater algorithms scientifically adequate? (In general, fate pathways include soil-to-air, soil-to-plants, soil-to-plants-to-animals, and subsurface soil to groundwater.)***

As indicated in the General Comments, the Technical Support Document generally follows the same format as *Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions* (U.S. EPA, 1998) and has even retained many of the model component names and symbols introduced in that document. In some cases, the algorithms used to model the fate of dioxins differ from those employed in the former document, but still appear to be scientifically adequate. One discrepancy noticed by this reviewer concerns the estimation of diffusivity in water. The authors used an equation that relies only on the molecular weight of a chemical to calculate diffusivity in water. Diffusivity is affected by many things including, temperature, atmospheric pressure, viscosity of water, and atomic and structural differences. Why didn't the authors consider the procedure described by Lyman et al. (1990) since they apparently used the approach to calculate diffusivity in air?

Robert Fares

Response to Charge no. 5 - ***Are the selected default values in the exposure pathway algorithms including but not limited to exposure assumptions, fate parameters, bioconcentration factors, decay rates, and all other parameters appropriate for the stochastic modeling runs as well as any deterministic runs performed in the risk assessment?***

Overall, the selected default values in the exposure pathway algorithms appear to be appropriate. However, this reviewer was curious regarding the maximum value assumed for fish ingestion. Throughout the document, the authors state that a third order stream was selected because

it represents the smallest water body that would routinely support recreational fishing of consumable fish. But the authors used the ingestion rate for subsistence fishers to account for high end exposure. Did the authors consider using a high percentile value for recreational fishers? Also, in Appendix C, the authors stated that the assumption for "veg" (the fraction of vegetative cover for the inactive source) was based on professional judgment, yet they assigned a Normal distribution for use in the stochastic model. That implies that enough is known about the data that professional judgement would not be necessary. This needs to be clarified in the document. There is also some confusion in Section 6 in Tables that contain information on multiple distribution types. In those Tables (6-4, 6-6, 6-8, 6-10, and 6-24), the parameters of Gamma and Weibull distributions are erroneously labeled "Pop-Estd Mean" and "Pop-Estd Sdev". Those values actually represent "Pop-Estd Shape" and "Pop-Estd Scale" values. A footnote is needed in those Tables to make that clarification.

This reviewer had some questions regarding the analytical approach used by the authors to develop probability distribution functions (PDFs) for the stochastic modeling effort. Use of maximum likelihood estimation is appropriate to fit parametric models to data. This reviewer questions the use of chi-square to assess goodness of fit. One of the weaknesses of the chi-square test is that different conclusions can be drawn from the same data depending upon how many intervals are specified. The Kolmogorov-Smirnov test, on the other hand, is not interval-dependent, thereby making it more powerful than the chi-square test. However, it is not very effective in detecting discrepancies in the tails of data. The Anderson-Darling test also is not interval-dependent, and places more emphasis on the tail values. This approach is more robust than either chi-square or Kolmogorov-Smirnov.

Robert Fares
Response to Charge no. 6 - ***Are the calculations for each of the exposure pathway algorithms performed correctly?***

This charge cannot be answered fully until Appendix H is corrected so that the equation operands are visible. This inadequacy was reported on December 7, but no one at EPA was available to distribute the corrected Appendix H to reviewers. Also, with regard to risks, the authors inserted a comment following Section 7.1.2 that Sections 7.1.3 through 7.2 have not been revised to reflect new sample data.

Robert Fares
Specific Comments:

Page	¶	Line(s)	Comment
2-9			Table 2-2 should be presented after it is introduced in the body of text.
4-2			Table 4-1. Insert Source for fraction organic carbon.
	4	**5**	The authors indicated that the strata were given weights of 0.0035,0.03902,0.23027, or 0.71921. Shouldn't the sum of these values equal 1.00000?

Page	¶	Line(s)	Comment
4-19	**3**	**7**	What are the units of the conversion factor 174?
5-18			Table 5-3. Concentrations are missing.
5-22			Table 5-5. Concentrations are missing.
5-29			Equation 5-11 key. For Dp, Where in the report is it calculated?
5-30			Equation 5-12 key. For C_{vapor}, Where in the report is it calculated?
			Table 5-8. Concentrations are missing.
5-31			Equation 5-13 key. For C_{soil}, Where in the report is it calculated?
			Equation 5-13 key. For Kd, Where in the report is it calculated?
5-32			Table 5-10. Concentrations are missing.
5-34			Equation 5-14 key. For P_{forage}, Where in the report is it calculated?
			Equation 5-14 key. For P_{feed}, Where in the report is it calculated?
5-35			Equation 5-15 key. For P_{forage}, Where in the report is it calculated?
			Equation 5-15 key. For P_{feed}, Where in the report is it calculated?
5-36			Table 5-12. Concentrations are missing.
5-37			Table 5-14. Concentrations are missing.
5-38			Table 5-16. Concentrations are missing.
5-39			Equation 5-16 key. For P_{forage}, Where in the report is it calculated?
5-41			Table 5-18. Concentrations are missing.
5-43			Equation 5-16. Change "BASF" to "BSAF".
			Equation 5-16 key. Change "BASF" to "BSAF".
6-8			Table 6-4. Footnote "Pop-Estd Mean" and "Pop-Estd SDev" values for Gamma distribution indicating that they represent "Pop-Estd Shape" and "Pop-Estd Scale" values.
6-10			Table 6-6. Footnote "Pop-Estd Mean" and "Pop-Estd SDev" values for Gamma distributions indicating that they represent "Pop-Estd Shape" and "Pop-Estd Scale" values.
6-11			Table 6-8. Footnote "Pop-Estd Mean" and "Pop-Estd SDev" values for Weibull distributions indicating that they represent "Pop-Estd Shape" and "Pop-Estd Scale" values.

Page	¶	Line(s)	Comment
6-13			Table 6-10. Footnote "Pop-Estd Mean" and "Pop-Estd SDev" values for Gamma distribution indicating that they represent "Pop-Estd Shape" and "Pop-Estd Scale" values.
6-27			Table 6-24. Footnote "Pop-Estd Mean" and "Pop-Estd SDev" values for Gamma distribution indicating that they represent "Pop-Estd Shape" and "Pop-Estd Scale" values.
7-2			Table 7-1. Concentrations and TEQ values are missing.
7-11			Table 7-12. Risks and Risk-Limiting Concentrations are missing.
7-13	**4**	**1**	If the data in Table 7-16 is correct, change "shows risk" to "shows no risk".
7-14	**2**	**1**	If the data in Table 7-17 is correct, change "shows risk" to "shows no risk".
	4	**1**	If the data in Table 7-18 is correct, change "shows risk" to "shows no risk".
App. B Page 2	**6**	**1-2**	Change "$P[B_h/A_h]$" to "$P[B_h\|A_h]$".
C-3	**6**		Change "enchrichment" to "enrichment".
C-6	**4**		If the assumption for "veg" is based on professional judgment how can the authors justify a Normal distribution? That implies that enough is known about the data that professional judgement would not be necessary. Please explain.
D-4	**2**	**5-7**	The authors used an equation that relies only on the molecular weight of a chemical to calculate diffusivity in water. Why didn't they consider the procedure described by Lyman et al. (1990)?
App. F Page iv			Appendix F has four appendices (A, B, C, D). Please consider renaming them (F-A, F-B, F-C, F-D) to avoid confusion with the other Appendices in this document.
F-78	**4**	**2**	Change "previously used the LAU" to "previously used in the LAU".
H-26			Table H-2.21 key. Merge the last two descriptions to read as "Empirical slope coefficient related to the power of the drainage area. B = 0.125 (unitless)"
H-28			Table H-2.23 key. Where in the report are the values for parameters "a" and "b" located?
H-30			Table H-3.1 key. For P_{feed}, Where in the report is it calculated?

Page	¶	Line(s)	Comment
			Table H-3.1 key. For P_{forage}, Where in the report is it calculated?
H-31			Table H-3.2 key. For P_{feed}, Where in the report is it calculated?
			Table H-3.2 key. For P_{forage}, Where in the report is it calculated?
H-32			Table H-3.3 key. For P_{feed}, Where in the report is it calculated?
			Table H-3.3 key. For P_{forage}, Where in the report is it calculated?
H-33			Table H-3.4 key. For P_{feed}, Where in the report is it calculated?
			Table H-3.4 key. For P_{forage}, Where in the report is it calculated?
H-34			Table H-3.5. Change "BASF" to "BSAF".
H-36			Table H-3.7 key. For P_exfruit, Where in the report is it calculated?
			Table H-3.7 key. For P_exveg, Where in the report is it calculated?
H-39			Table H-3.10 key. For C_fishT3F, Where in the report is it calculated?
			Table H-3.10 key. For C_fishT4F, Where in the report is it calculated?
			Table H-3.10 key. Change "CRf" to "CRfish".
H-42			Table H-3.14 key. For Csoil, Where in the report is it calculated?
H-45	**Note**	**1**	Table H-3.16 key. Change "vegetataion" to "vegetation".
		2	Table H-3.16 key. Change "vegetataion" to "vegetation".
J-28	**1**	**10-11**	The authors stated that a subsistence fisher ingestion rate was used as the maximum for the adult recreational fisher assessment. Did the authors consider using a high percentile value for recreational fishers?
J-30			Table J-15. Why did the authors assume 100 years as a maximum value for exposure duration for adult residents, children, and adult farmers? This doesn't seem realistic.
K-3	**2**	**1**	Change "TEQ concentration" to "TEQ concentrations".

Document No. 2 (The Risk Characterization)

Robert Fares

Response to Charge no. 1 - ***Do you agree with the risk characterization based upon your review***

of the exposure evaluation and the risk assessment in the Technical support Document?

This reviewer agrees with the risk characterization based on the review of the exposure evaluation and the risk assessment in the Technical Background Document. However, it is this reviewers understanding that some of the results in Sections 7.1.3 through 7.2 of the Technical Background Document may change as a result of new data input.

Document No. 3 (Estimate of Population Modeled and Annual Cancer Cases from the Modeled Population))

Robert Fares
Response to Charge no. 1 - ***Are the assumptions that are stated in the estimates reasonable?***

The assumptions stated in the estimates appear to be reasonable.

Robert Fares
Response to Charge no. 2 - ***Are the calculations for the estimated population modeled and the annual cancer cases from the population performed correctly?***

The calculations for the estimated population and annual cancer cases from the population were performed correctly.